

AMERICAN CYANAMID COMPANY
WARNER'S PLANT
LINDEN, NEW JERSEY

PRELIMINARY REPORT OF
SOIL BORINGS AND MEASUREMENT
OF PERMEABILITIES AT
THE WARNER'S PLANT IMPOUNDS

September 1981

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ENVIRONMENTAL ENGINEERING CONSULTANTS

September 11, 1981

Mr. Michael Caponegro
American Cyanamid Company
Warner's Plant
P. O. Box 31
Linden, New Jersey 07036

Subject: Preliminary Report of Soil Borings and
Measurement of Permeabilities at the
Warner's Plant Impounds

Dear Mr. Caponegro:

Enclosed please find four (4) copies of our report on the second stage investigation of the permeabilities of sludge and underlying soils at the Warner's Plant Impounds.

Core borings were taken at the impounds during the period July 28 to 31, 1981. Two borings were taken at each impound at approximately the same locations that were sampled for the initial permeability investigation, one near the center, and one at the edge.

Permeability tests were performed in the laboratory on samples of the sludge taken at depths of 1 to 2 feet above the sludge/soil interface, and on samples of the underlying silt layer. The samples from the silt layer were taken at depths varying from 3 to 13 feet below the sludge/soil interface. A layer of organic, meadow mat exists below the sludge. The meadow mat varies from 2 to 12 feet in thickness.

The coefficients of permeability of the sludge samples at the bottom of the impounds range from 8×10^{-5} to 6×10^{-6} cm/sec., and the permeability coefficients for the subsurface silt samples range from 6×10^{-6} to 2×10^{-7} cm/sec.

Generally, the coefficients of permeability of the sludge at the bottom of the impounds were lower than the coefficients of permeability of the sludge at the upper sludge layers. However, the values obtained are still a little higher than the 10^{-7} cm/sec. that the State regulations stipulate for an impermeable liner.

Mr. Caponegro - Page 2
Sept. 11, 1981

Although the values for the silt layer are very close to the State requirements for an impervious liner, they do not fully satisfy the requirements.

In order to make further evaluations, the following steps are recommended for consideration:

1. Take core borings through the depth of the impounds and the underlying soil to the shale bedrock. This would allow for an evaluation of the thickness of the silt layer and depth to the Brunswick Formation, a major aquifer.
2. Take core borings through the dikes to determine the dike depths below the original ground line, and whether clay cut-off walls were constructed.
3. Review of the groundwater use in the area including a listing of the wells tapping the Brunswick Formation within a 1 mile radius of the site.
4. Make preliminary cost estimates of capping the lagoons with a final cover and constructing clay cut-off walls. Estimate costs of drainage swales.

We can perform part or all of such a work program if desired. Please contact me if you wish to discuss this further.

We again appreciate the opportunity to be of service to American Cyanamid Company in this project. If you have any questions concerning the report, please contact me.

Very truly yours,



Michael Disko, Ph.D., P.E.

MD/bd

cc: E. Wuensch
S. Hathaway

Enc.

1. INTRODUCTION

In June 1981, a preliminary report on the permeabilities of the alum sludge at the American Cyanamid Warner's Plant impounds was prepared by M. Disko Associates. The surface sludge field density ranged from 36 to 82 lbs/ft.³ and the permeability ranged from 1×10^{-4} to 8×10^{-6} cm/sec. Although the results indicated that the sludge is relatively impermeable, the New Jersey Department of Environmental Protection regulations consider 10^{-7} cm/sec as the requirement for an impermeable liner.

Since the surface sludge would be expected to be more permeable than the consolidated bottom sludge and since the permeabilities obtained were not representative of the permeability at the base of the impounds, it was proposed that core borings be taken through the depth of the impounds to reach the underlying soil. Samples would be obtained every foot to a depth of at least 5 feet below the bottom of the impound. Determinations would be made of the permeability of the sludge just above the soil base of the impounds, and of the soils at the base of the impounds.

Core borings were undertaken and samples collected during the last week of July 1981. Two borings were taken at each of the six impounds: one near the edge and one near the center, for a total of 12 borings. The borings were obtained using a hand-carried, portable tripod rig.

2. SOIL BORINGS

Twelve soil borings were taken during the period July 28 to 31, 1981 by P. J. Healey Company, Inc. of Fanwood, New Jersey. Two borings were taken at each impound. The depths of the borings varied depending on the thickness of the sludge layer, and ranged from 10 feet at the edge of Impound #2 to 29 feet at the center of Impound #6. Sludge depths varied from 5 feet at the edge of Impound #2 to 20 feet at the edge of Impound #5. Borehole depths and sludge depths are tabulated in Table 1.

All the borings show that the sludge overlies a layer of organic meadow mat. The meadow mat layer varied in thickness from 2 feet at the edge of Impound #3 to 12 feet at the center of Impound #6.

Meadow mat refers to a surface layer of dead and decomposing reeds and grasses together with silt or clay. Meadow mat is found in tidal marsh areas. The meadow mat is relatively pervious.

Underlying the meadow mat is a layer of gray organic silts, which in some boreholes was mixed with sand and clay. The borings were terminated in the organic silt layer. The depth to this layer varied from 9 feet at the edge of Impound #3 to 27 feet at the center of Impound #6. Meadow mat thicknesses and depths to the organic silt layer for the various boreholes are tabulated in Table 1.

TABLE 1

SOIL BORING DATA

| <u>BOREHOLE DESIGNATION</u> | <u>TOTAL BOREHOLE DEPTH, FT.</u> | <u>SLUDGE DEPTH, FT.</u> | <u>MEADOW MAT THICKNESS FT.</u> | <u>DEPTH TO SILT LAYER, FT.</u> |
|---------------------------------|--|------------------------------|---|---|
| #1 Edge | 16 | 7 | 8 | 15 |
| #1 Center | 15 | 8 | 6 | 14 |
| #2 Edge | 10 | 5 | 4.5 | 9.5 |
| #2 Center | 12 | 6 | 5 | 11 |
| #3 Edge | 12 | 7 | 2 | 9 |
| #3 Center | 12 | 6 | 5 | 11 |
| #4 Edge | 19 | 15 | 3 | 18 |
| #4 Center | 24 | 17 | 4 | 21 |
| #5 Edge | 27 | 20 | 3 | 23 |
| #5 Center | 18 | 14 | 3.5 | 17.5 |
| #6 Edge | 26 | 18 | 7 | 25 |
| #6 Center | 29 | 15 | 12 | 27 |
| | <u>220 L.F.</u> | | | |

The soils encountered in the borings are consistent with the soil types of a tidal marsh. The tidal marsh soil is of marine origin and is mainly composed of silty clays. These silty clays were deposited in salt water during the recession period of the Wisconsin Glaciation.* The soil material is made up of dark-brown or black silty clay loam containing varying amounts of decaying vegetation. The sub-soil layer consists mainly of dark-gray or bluish gray silty clay. The surface layer is called meadow mat.

The silty-clay composition of the subsurface soil makes it exceedingly poorly drained and gives it a very low permeability.

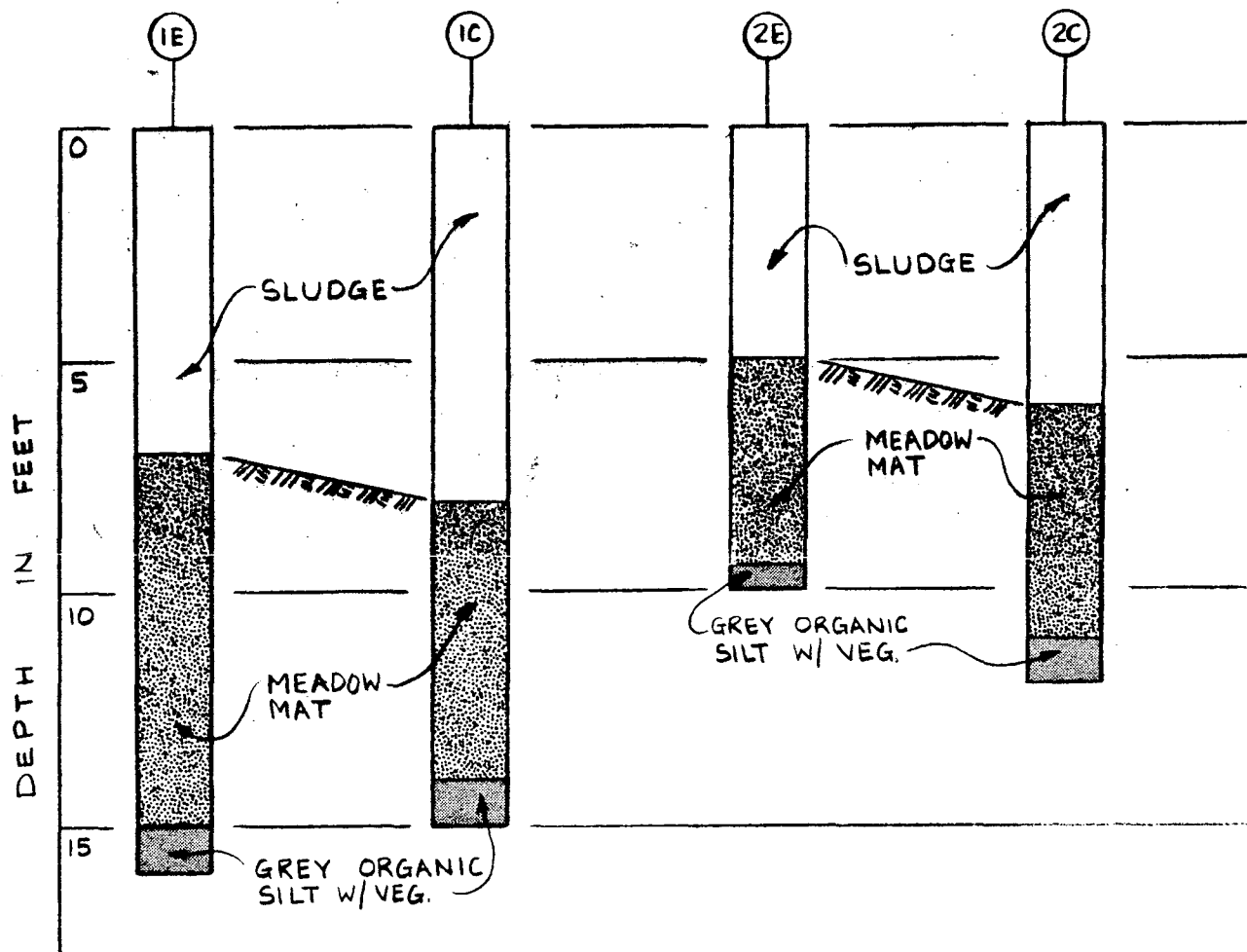
The U. S. Department of Agriculture Soil Conservation Service reports that the depth to bedrock in the tidal marsh soil exceeds 10 feet.

The borehole logs are shown in Figures 1, 2 and 3.

Boring logs are enclosed in the Appendix.

*Last period of glaciation in northern and central New Jersey, about 10,000 years ago.

AMERICAN CYANAMID COMPANY WARNER'S PLANT SLUDGE IMPOUNDS



LEGEND

- ①E IMPOUND #1 AT EDGE
- ②C IMPOUND #2 AT CENTER

FIGURE 1 SOIL BORING LOGS-IMPOUNDS #1 & #2

SCALE: 1" = 4' VERT.

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CONSULTING ENGINEERS

AMERICAN CYANAMID COMPANY WARNER'S PLANT SLUDGE IMPOUNDS

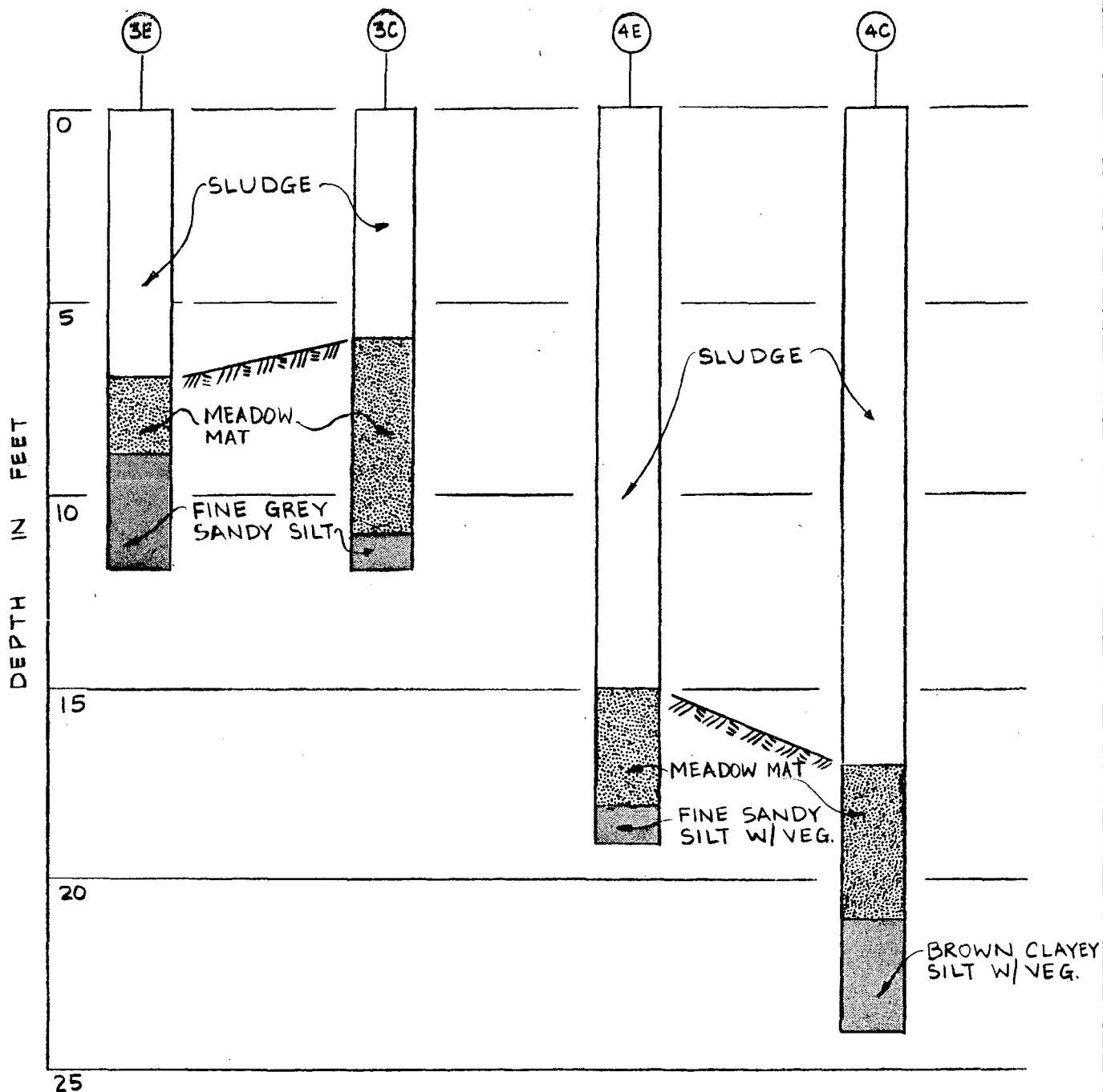


FIGURE 2 SOIL BORING LOGS - IMPOUNDS #3 & #4

SCALE: 1" = 4' VERT.

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CONSULTING ENGINEERS

AMERICAN CYANAMID COMPANY WARNER'S PLANT SLUDGE IMPOUNDS

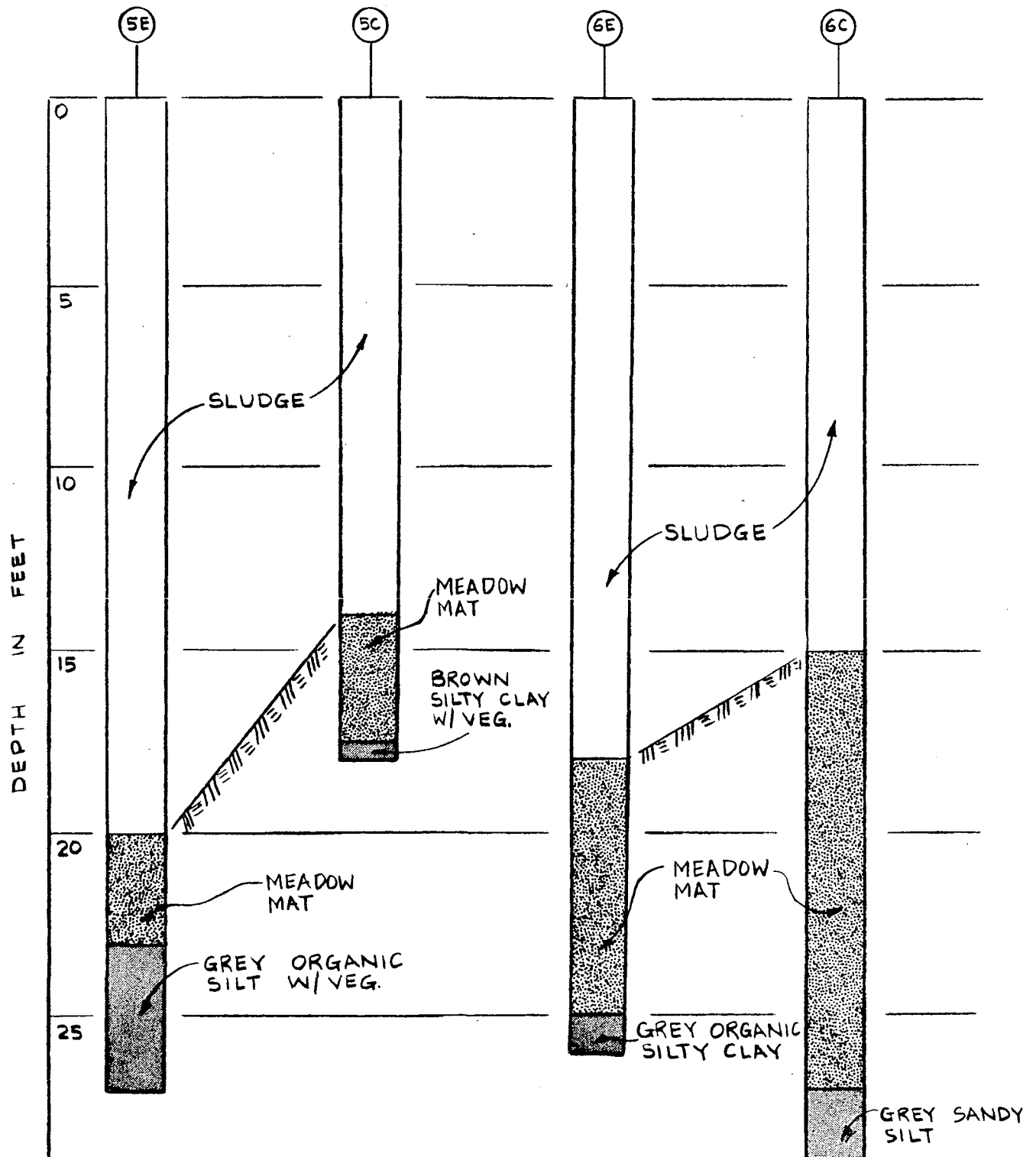


FIGURE 3 SOIL BORING LOGS - IMPOUNDS #5 & #6

SCALE: 1" = 4' VERT.

M. DISKO ASSOCIATES
CONSULTING ENGINEERS

3. GEOLOGY OF AREA

Middlesex County lies within two major physiographic provinces - the Atlantic Coastal Plain and the Piedmont. The impound area in Carteret lies within the Piedmont Province.

During the late Triassic Epoch,* downfaulting produced a series of northeastward-trending basins in the Piedmont Plateau from North Carolina to Nova Scotia. Sedimentary and associated igneous rocks of Triassic Age occupy the downfaulted basins and are known as the Newark Group. In New Jersey, the Newark Group crops out in a band 16 to 30 miles wide trending northeast-southwest from the Delaware River to the Hudson River. The bedrock in the Carteret area is a part of the Newark Group of the late Triassic Age.

The sedimentary rocks of the Newark Group in New Jersey are composed of reddish brown sandstone, mudstone, siltstone, and conglomerate, and dark-grey argillite. The sediments were derived largely from rocks of Paleozoic (over 200 million years ago) and Precambrian Age (over 500 million years ago) to the southeast and were deposited in a non-marine basin.

The Newark Group has been divided into three formations on the basis of distinctive lithology: a lower unit, the Stockton

*Triassic Epoch existed from about 160 to 125 million years ago.

Formation; a middle unit, the Lockatong Formation; and an upper unit, the Brunswick Formation.

The Brunswick Formation forms the bedrock throughout most of the Carteret area. It is reddish-brown and composed of mudstone, siltstone, sandstone, and conglomerate. The thickness of the Brunswick Formation in this area has been estimated to be about 6000 to 8000 feet. To the southwest the formation reaches a maximum thickness of 16,000 feet.

The Brunswick Formation consists of a monotonous succession of reddish-brown siltstone and mudstone with local beds of claystone and fine-grained sandstones. The upper part of the Brunswick Formation contains three thick lava flows interbedded with the mudstones and siltstones. Commonly, two kinds of mudstone occur in alternating sequences. One is bright reddish-brown, crumbly mudstone to claystone; the other is more resistant, massive silty mudstone with channel deposits of fine-grained sandstone.

Soil borings conducted on the neighboring tidal marsh area of the American Cyanamid Landfill in Linden indicated that the Brunswick shale underlying that area is approximately 20 to 25 feet below mean sea level.

Unconsolidated deposits overlying the Newark Group consist of sand, gravel, silt and clay, that were deposited largely during the last (Wisconsin) glaciation (about 10,000 years ago) of the

Pleistocene Epoch.* The Pleistocene sediments fall into three general classes: (1) end moraine - a moraine jointed across the course of a glacier at its farthest advance; (2) ground moraine - the material carried forward in and beneath the ice and finally deposited from its under surface; and (3) stratified drift - deposits from glacial meltwater exhibiting both sorting and stratification. The sediments in the project area are classed as ground moraine.

The area was once a tidal marsh formed in a marine environment during the retreat of the Wisconsin Glacier. The soils of the tidal marsh are mostly silts and clays. The upper horizon of the tidal marsh consists of a grey, organic silt containing decomposed roots and grasses from the surface ground cover.

Generally, the organic mat extends from the surface to a depth varying from two feet to more than twelve feet. Highly organic sand, silt, clayey silt and clay extend down to the underlying formation for variable depths. Drainage within these soils is exceedingly poor. The tidal marsh area is highly undefined and large variations in characteristics can occur within a small region.

*The Pleistocene Epoch is the period within the last 1 million years.

4. PERMEABILITY TESTS

4.1 Introduction

Permeability tests were conducted on samples taken from the core boreholes. For each borehole, two permeability tests were performed; one on samples of the sludge at a depth of 1 to 2 feet above the sludge/soil interface, and the other on samples from the silt layer. The samples from the silt layer were taken at depths varying from 3 to 13 feet below the sludge/soil interface.

4.2 Description of Permeability Test

The coefficient of permeability was calculated using the falling head test method on a boring sample. The boring sample is placed into a permeameter cylinder and subjected to a head of water. The head at the beginning of the test is recorded and then at a later time during the test the level of water in the pipette is measured again. The coefficient of permeability is calculated for each time test and then these values are combined to yield an average coefficient of permeability for the sample.

The formula used to calculate the falling head permeability was:

$$K = 2.3 \frac{aL}{AT} \log_{10} \frac{H_0}{H}$$

where:

K = coefficient of permeability, cm/sec.

A = cross sectional area of permeameter, cm²

L = length of specimen, cm

a = cross sectional area of standpipe (pipette), cm²

T = time of test, sec.

H₀ = head at start of test, cm

H = head at end of test, cm

It should be noted that the variables, A, L , and a are constant for each sample.

4.3 Permeability Values

The average coefficient of permeability for each sample tested is given in Table 2. Also shown in Table 2 are the coefficients of permeability for sludge samples taken at the top of the sludge layer. These values were obtained from the June 1981 report. The boreholes for this study were taken at approximately the same locations as the earlier sampling points.

The coefficients of permeability of the sludge samples at the bottom of the impounds range from 8×10^{-5} to 6×10^{-6} cm/sec. The permeability coefficients for the subsurface soil samples was in the range of 6×10^{-6} to 2×10^{-7} cm/sec. In order to put the coefficients of permeability into proper perspective, comparison can be made with the values listed below for various soil types.

| <u>Soil Type</u> | <u>Approximate Permeability Coefficient cm/sec</u> |
|---|--|
| Gravel | 10^2 to 3×10^{-1} |
| Sand | 3×10^{-1} to 10^{-3} |
| Very fine sands and silts, mixtures of sand with silt, mixtures of silt with clay | 10^{-3} to 10^{-7} |
| Clay | 10^{-7} or less |

Generally, the permeability coefficients for the bottom sludge samples are lower than the samples from the upper sludge layers.

TABLE 2

PERMEABILITIES OF SLUDGE AND SOIL SAMPLES
FROM IMPOUNDS AT AMERICAN CYANAMID WARNER'S PLANT

| BOREHOLE DESIGNATION | COEFFICIENT OF PERMEABILITY, CM/SEC | | UNDERLYING SOIL** |
|----------------------|-------------------------------------|-----------------------|-----------------------|
| | SLUDGE TOP* | BOTTOM** | |
| 1. #1 Edge | 1.19×10^{-4} | 1.49×10^{-5} | 1.07×10^{-6} |
| 2. #1 Center | 6.57×10^{-6} | 3.65×10^{-5} | 2.43×10^{-6} |
| 3. #2 Edge | 5.61×10^{-5} | 1.67×10^{-5} | 3.00×10^{-6} |
| 4. #2 Center | 6.05×10^{-5} | 1.05×10^{-5} | 2.20×10^{-7} |
| 5. #3 Edge | 4.02×10^{-5} | 2.58×10^{-5} | 1.63×10^{-6} |
| 6. #3 Center | 2.63×10^{-5} | 5.90×10^{-6} | 1.44×10^{-6} |
| 7. #4 Edge | 1.03×10^{-4} | 8.07×10^{-6} | 6.34×10^{-6} |
| 8. #4 Center | 5.73×10^{-5} | 3.06×10^{-5} | 4.87×10^{-6} |
| 9. #5 Edge | 8.06×10^{-6} | 8.00×10^{-5} | 3.87×10^{-6} |
| 10. #5 Center | 2.28×10^{-5} | 3.09×10^{-5} | 2.40×10^{-7} |
| 11. #6 Edge | 1.34×10^{-5} | 9.15×10^{-6} | 4.12×10^{-6} |
| 12. #6 Center | 1.62×10^{-5} | 2.67×10^{-5} | 3.25×10^{-7} |

*Results from June 1981 Report

**Results from August and September 1981 Testing.

NOTE: Underlying soil is silt layer under the sludge and meadow mat.

However, the values obtained are still a little higher than the value of 10^{-7} cm/sec that the State regulations stipulate for an impermeable liner.

The coefficients of permeability for the subsurface soil are typical for silt and silt/clay mixtures. The values do not technically satisfy the impervious liner requirement but are very close to it.

5. ENVIRONMENTAL ASPECTS

The key concerns that Federal and State regulatory agencies might have are the potential effects of sludge leachate or contaminated water on local surface waters and the groundwater.

The toxic effect of any possible sludge contaminated runoff from rainfall or leachate from the impounds on surface waters could be significant. Any impact is mitigated somewhat by the tidal nature of this section of the Rahway River which is the receiving waterway. In addition, the relatively poor water quality of the tidal reaches of the Rahway and the Arthur Kill make impacts from the sludge lagoon more difficult to evaluate fully and measure.

The potential effects of sludge leachate on the Brunswick Formation could be a very significant area of concern and probably would be the major thrust of any enforcement action by Federal and State agencies. The Brunswick Formation is the major aquifer in Union County and underlies most of Union County and part of Middlesex County.

A 1976 report entitled, "Geology and Groundwater Resources of Union County, New Jersey", published by the U. S. Geological Survey, listed 230 wells tapping the Brunswick Formation. These wells include numerous industrial firms in Linden and both public and industrial sources in Rahway. The study presents only a partial inventory of wells.

Further research would be necessary to list and evaluate local wells around the area of the impounds and possible impacts. This is beyond the scope of this report.

In order to minimize future concerns about the impounds, several alternatives could be considered:

1. Total excavation and removal of sludges from the impounds to other secure storage facilities is not economically feasible. Large acreage with relatively deep sludge depths are involved. For example, Impound #4 contains over 200,000 cubic yards of sludge. Excavation, haulage and disposal at \$20 to \$50 per cubic yard would cost millions of dollars for Impound #4 alone.
2. Capping the top and sides of the impounds to "seal" the lagoon is a possible alternative. The principal of this alternative is to prevent annual rainfall from constantly percolating into the impounds and causing a hydraulic head to force leachate into the meadow mat both vertically and laterally. Preventing water from constantly entering the sludge deposits will reduce the long term potential of leachate contamination of the Brunswick shale aquifer. The meadow mat must be blocked using "cut-off walls" to prevent lateral flow of leachate if the existing dikes do not extend into the grey silt. This alternative will be expensive but is a magnitude less costly than the first alternate.
3. If Federal or State enforcement becomes focused on these lagoons, "capping" the lagoons, together with possible pumping of the

aquifer to reverse groundwater flow may become a forced alternative.

Efforts should probably be centered on Alternative #2, which involves capping the top and sides of the impounds.

6. CONCLUSIONS AND RECOMMENDATIONS

The measured coefficients of permeability show that there would be slow movement of water within the sludge. Any downward vertical movement of water would result in leachate percolating into the meadow mat, and from there into the underlying silt layer. The coefficient of permeability in the silt layer ranges from 6×10^{-6} to 2×10^{-7} cm/sec. or very close to the State requirement of 10^{-7} cm/sec. Since it is not 10^{-7} cm/sec., however, the silt soil would not be accepted by the State as an impervious liner.

Movement of water through the silt layer would be very slow. The depth to this layer varies from 9 to 27 feet from the surface of the sludge.

The depth of the silt layer was not determined during the core boring program, since all the borings terminated at 2 to 3 feet into the silt layer. However, the literature suggests that depth to bedrock is greater than 10 feet. Borings at the American Cyanamid landfill about a mile away, indicated a depth to bedrock of 20 to 25 feet.

Knowledge of the depth of this layer is important to the study of the effects of percolation into the groundwater of the aquifer of the Brunswick Formation. If it can be determined that leachate from the impounds would move very slowly, then methods which reduce leaching, such as capping of the impounds, would be effective.

Although borings to determine the depth to bedrock are important, another problem needs to be investigated. The sludge layer is separated from the silt layer by a layer of meadow mat. The meadow mat mayer varies from 2 to 12 feet, with most of the depths in the 3 feet to 6 feet range. Meadow mat is more permeable than the silt subsurface. This can result in lateral movement of leachate into the surrounding rivers and streams. This lateral movement can be confined within the impound area by impervious cut-off walls. It might be possible that clay cut-off trenches were built during the building of the dikes around the impounds. However, verification of the depths of clay below the dike is needed. This can be accomplished by boreholes extending from the top of the dikes to the silt subsurface layer.

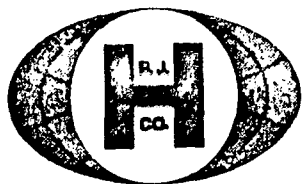
It seems, therefore, that further studies are needed in order to fully evaluate the situation at the impounds. The following steps are recommended for consideration.

1. Evaluation of the thickness of the silt layer and the depth to the Brunswick Formation by taking several boreholes to the shale.
2. Evaluation of the dike depth below the original ground line, and the presence or absence of clay cut-off walls. This can be accomplished by a number of borings through the dikes and in the immediate vicinity of the dikes.
3. Review of the groundwater use in the area including a listing of the wells tapping the Brunswick Formation within a one mile radius of the site and related data.

4. Preliminary layouts and cost estimates of capping the lagoons with an impermeable final cover and cut-off walls. Estimates of costs of drainage swales and other drainage needs. All of this information would be valuable in evaluating options.

APPENDIX

SOIL BORINGS



PHILIP J. HEALEY COMPANY est. 1870

43 SOUTH AVENUE, FANWOOD, NEW JERSEY 07023

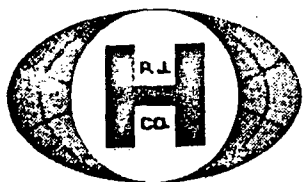
(201) 322-6500

TEST BORING DATA

Project: American Cyanamid TEST HOLE NO. 1-E
 Location: Carteret, New Jersey Sheet 1 of 1
 Boring Contractor: Philip J. Healey Company Surface Elevation:
 Inspector: Ground water observations
 Date Started: 7/31/81 Depth: 2.0' Date: 7/31/81
 Date Completed: 7/31/81 Depth: Date:

| Casing Blows | SAMPLE NO. DEPTH | | BLOWS ON SPOON | | | | REC. | SAMPLE IDENTIFICATION AND PROFILE CHANGE | ELEV. |
|-----------------|---------------------|------|----------------|---------|----------|----------|------|--|-------|
| | | | 0 6 | 6 12 | 12 18 | 18 24 | | | |
| | S-1 | 0.0 | 3.0 | P | P | P | P | SLUDGE | 2.0' |
| | | | | P | P | | | | |
| 5 | S-2 | 3.0 | 6.0 | P | P | P | P | | |
| | S-3 | 6.0 | 9.0 | P | P | P | P | PEAT | 7.0 |
| | | | | P | P | | | | |
| 10 | S-4 | 9.0 | 12.0 | P | P | P | P | | |
| | S-5 | 12.0 | 13.0 | P | P | P | P | Gray Organic SILT, vegetation | 15.0' |
| | S-6 | 13.0 | 16.0 | P | P | P | P | | 16.0' |
| 15 | | | | P | P | | | | |
| | | | | | | | | End of Boring | |
| 20 | | | | | | | | | |
| | | | | | | | | | |
| 25 | | | | | | | | | |
| | | | | | | | | | |
| 30 | | | | | | | | | |
| | | | | | | | | | |
| 35 | | | | | | | | | |
| | | | | | | | | | |
| 40 | | | | | | | | | |

| | | | | | | | | | |
|-------------------|----|-----------------------|-----|-----------|-------------|----------|----------|---------|-------|
| I. D. Casing | in | Wgt. Hammer on Casing | lb | Symbol | a. | s. | l. | t. | |
| I. D. Spoon 1-3/8 | in | Wgt. Hammer on Spoon | 140 | lb | Proportions | and | some | little | trace |
| Type Core Drill | | Drop Hammer on Casing | in | % By Wgt. | 35 to 50 | 20 to 35 | 10 to 20 | 1 to 10 | |
| Core Dia. | in | Drop Hammer on Spoon | 30 | in | | | | | |



PHILIP J. HEALEY COMPANY est. 1870

43 SOUTH AVENUE, FANWOOD, NEW JERSEY 07023

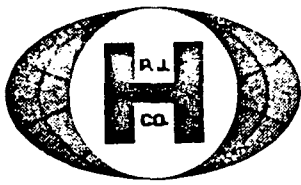
(201) 322-6500

TEST BORING DATA

Project: American Cyanamid TEST HOLE NO. 1-C
 Location: Carteret, New Jersey Sheet 1 of 1
 Boring Contractor: Philip J. Healey Company Surface Elevation:
 Inspector: Ground water observations
 Date Started: 7/31/81 Depth: 7.5' Date: 7/31/81
 Date Completed: 7/31/81 Depth: Date:

| | Casing Blows | SAMPLE NO. DEPTH | | BLOWS ON SPOON | | | | REC. | SAMPLE IDENTIFICATION AND PROFILE CHANGE | ELEV. |
|----|-----------------|---------------------|------|----------------|---------|----------|----------|------|--|-------|
| | | | | 0 6 | 6 12 | 12 18 | 18 24 | | | |
| | | S-1 | 0.0 | 3.0 | P | P | P | P | SLUDGE | |
| | | | | | P | P | | | | |
| | | S-2 | 3.0 | 6.0 | P | P | P | P | | |
| | | | | | P | P | | | | |
| 5 | | | | | | | | | | |
| | | S-3 | 6.0 | 9.0 | P | P | P | P | PEAT | 7.5' |
| | | | | | P | P | | | | 8.0' |
| | | | | | | | | | | |
| | | | | | | | | | | |
| 10 | | S-4 | 9.0 | 12.0 | P | P | P | P | Gray SILT, vegetation | |
| | | | | | P | P | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | S-5 | 12.0 | 15.0 | P | P | P | P | End of Boring | 14.0' |
| | | | | | P | P | | | | 15.0' |
| 15 | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| 20 | | | | | | | | | | |
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| 25 | | | | | | | | | | |
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| 30 | | | | | | | | | | |
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| 35 | | | | | | | | | | |
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| | | | | | | | | | | |
| 40 | | | | | | | | | | |

| | | | | | | | | |
|-----------------|----------|-----------------------|--------|-------------|----------|----------|----------|---------|
| I. D. Casing | in | Wgt. Hammer on Casing | lb | Symbol | a. | s. | l. | t. |
| I. D. Spoon | 1-3/8 in | Wgt. Hammer on Spoon | 140 lb | Proportions | and | some | little | trace |
| Type Core Drill | | Drop Hammer on Casing | in | % By Wgt. | 35 to 50 | 20 to 35 | 10 to 20 | 1 to 10 |
| Core Dia. | in | Drop Hammer on Spoon | 30 in | | | | | |



PHILIP J. HEALEY COMPANY est. 1870

43 SOUTH AVENUE, FANWOOD, NEW JERSEY 07023

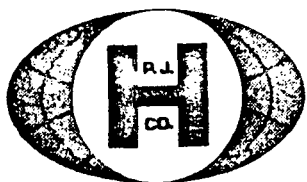
(201) 322-6500

TEST BORING DATA

Project: American Cyanamid TEST HOLE NO. 2-E
Location: Carteret, New Jersey Sheet 1 of 1
Boring Contractor: Philip J. Healey Company Surface Elevation:
Inspector: Ground water observations
Date Started: 7/29/81 Depth: 1.0' Date: 7/29/81
Date Completed: 7/29/81 Depth: Date:

| Casing Blows | SAMPLE NO. DEPTH | | BLOWS ON SPOON | | | | REC. | SAMPLE IDENTIFICATION AND PROFILE CHANGE | ELEV. |
|-----------------|---------------------|------|----------------|---------|----------|----------|------|--|-------|
| | | | 0 6 | 6 12 | 12 18 | 18 24 | | | |
| | S-1 | 0.0 | 2.0 | P | P | P | P | SLUDGE | 1.0' |
| | S-2 | 2.0 | 4.0 | P | P | P | P | | |
| 5 | S-3 | 4.0 | 6.0 | P | P | P | P | | 5.0' |
| | S-4 | 6.0 | 8.0 | P | P | P | P | PEAT | |
| | S-5 | 8.0 | 10.0 | P | P | P | P | | 9.5' |
| 10 | S-6 | 10.0 | 12.0 | P | P | P | P | Gray Organic SILT, vegetation | 10.0' |
| | | | | | | | | | |
| | | | | | | | | End of Boring | |
| | | | | | | | | | |
| 15 | | | | | | | | | |
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| 20 | | | | | | | | | |
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| 25 | | | | | | | | | |
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| 30 | | | | | | | | | |
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| 35 | | | | | | | | | |
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| 40 | | | | | | | | | |

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|-----------------|----------|-----------------------|--------|-------------|----------|----------|----------|---------|
| I. D. Casing | in | Wgt. Hammer on Casing | lb | Symbol | a. | s. | l. | t. |
| I. D. Spoon | 1-3/8 in | Wgt. Hammer on Spoon | 140 lb | Proportions | and | some | little | trace |
| Type Core Drill | | Drop Hammer on Casing | in | % By Wgt. | 35 to 50 | 20 to 35 | 10 to 20 | 1 to 10 |
| re Dia. | in | Drop Hammer on Spoon | 30 in | | | | | |



PHILIP J. HEALEY COMPANY est. 1870

43 SOUTH AVENUE, FANWOOD, NEW JERSEY 07023

(201) 322-6500

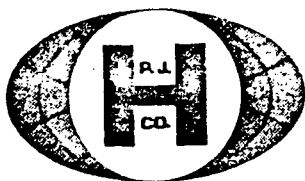
TEST BORING DATA

Project: American Cyanamid TEST HOLE NO. 3-E
 Location: Carteret, New Jersey Sheet 1 of 1
 Boring Contractor: Philip J. Healey Company Surface Elevation:
 Inspector: _____ Ground water observations _____
 Date Started: 7/28/81 Depth: _____ Date: 7/28/81
 Date Completed: 7/28/81 Depth: _____ Date: _____

| | Casing Blows | SAMPLE NO. DEPTH | | BLOWS ON SPOON | | | | REC. | SAMPLE IDENTIFICATION AND PROFILE CHANGE | ELEV. |
|----|-----------------|---------------------|------|----------------|---------|----------|----------|------|--|-------|
| | | | | 0 6 | 6 12 | 12 18 | 18 24 | | | |
| | | S-1 | 0.0 | 2.0 | P | P | P | P | SLUDGE | |
| | | S-2 | 2.0 | 4.0 | P | P | P | P | | |
| 5 | | S-3 | 4.0 | 6.0 | P | P | P | P | | |
| | | S-4 | 6.0 | 8.0 | P | P | P | P | | 7.0' |
| | | S-5 | 8.0 | 10.0 | P | P | P | P | PEAT, Btk. Silt | 9.0' |
| 10 | | S-6 | 10.0 | 12.0 | P | P | P | P | Gray f SAND, Silt | |
| | | | | | | | | | | 12.0' |
| | | | | | | | | | End of Boring | |
| 15 | | | | | | | | | | |
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| | | | | | | | | | | |
| 20 | | | | | | | | | | |
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| 35 | | | | | | | | | | |
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| 40 | | | | | | | | | | |

Depth in Feet

| | | | | | | | | |
|-----------------|----------|-----------------------|--------|-------------|----------|----------|----------|---------|
| I. D. Casing | in | Wgt. Hammer on Casing | lb | Symbol | a. | s. | l. | t. |
| I. D. Spoon | 1-3/8 in | Wgt. Hammer on Spoon | 140 lb | Proportions | and | some | little | trace |
| Type Core Drill | | Drop Hammer on Casing | in | % By Wgt. | 35 to 50 | 20 to 35 | 10 to 20 | 1 to 10 |
| Core Dia. | in | Drop Hammer on Spoon | 30 in | | | | | |



PHILIP J. HEALEY COMPANY est. 1870

43 SOUTH AVENUE, FANWOOD, NEW JERSEY 07023

(201) 322-6500

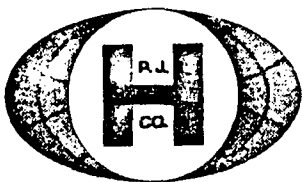
TEST BORING DATA

Project: American Cyanamid TEST HOLE NO. 4-C
 Location: Carteret, New Jersey Sheet 1 of 1
 Boring Contractor: Philip J. Healey Company Surface Elevation:
 Inspector: Ground water observations
 Date Started: 7/30/81 Depth: 4.0' Date: 7/30/81
 Date Completed: 7/30/81 Depth: Date:

Depth in Feet

| | Casing Blows | SAMPLE NO. DEPTH | | BLOWS ON SPOON | | | | REC. | SAMPLE IDENTIFICATION AND PROFILE CHANGE | ELEV. |
|----|-----------------|---------------------|-----------|----------------|---------|----------|----------|------|--|-------|
| | | | | 0 6 | 6 12 | 12 18 | 18 24 | | | |
| | | S-1 | 0.0 3.0 | P | P | P | P | | SLUDGE | |
| | | | | P | P | | | | | |
| 5 | | S-2 | 3.0 6.0 | P | P | P | P | | | 4.0' |
| | | | | P | P | | | | | |
| | | S-3 | 6.0 9.0 | P | P | P | P | | | |
| | | | | P | P | | | | | |
| 10 | | S-4 | 9.0 12.0 | P | P | P | P | | | |
| | | | | P | P | | | | | |
| | | S-5 | 12.0 15.0 | P | P | P | P | | PEAT | |
| | | | | P | P | | | | | |
| 15 | | S-6 | 15.0 18.0 | P | P | P | P | | Brn. Clayey SILT, vegetation | 17.0' |
| | | | | P | P | | | | | |
| 20 | | S-7 | 18.0 21.0 | P | P | P | P | | End of Boring | 21.0' |
| | | | | P | P | | | | | |
| | | S-8 | 21.0 24.0 | P | | | | | End of Boring | 24.0' |
| 25 | | | | | | | | | | |
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|-----------------|----------|-----------------------|--------|-------------|----------|----------|----------|---------|
| I. D. Casing | in | Wgt. Hammer on Casing | lb | Symbol | a. | s. | l. | t. |
| I. D. Spoon | 1-3/8 in | Wgt. Hammer on Spoon | 140 lb | Proportions | and | some | little | trace |
| Type Core Drill | | Drop Hammer on Casing | in | % By Wgt. | 35 to 50 | 20 to 35 | 10 to 20 | 1 to 10 |
| Core Dia. | in | Drop Hammer on Spoon | 30 in | | | | | |



PHILIP J. HEALEY COMPANY est. 1870

43 SOUTH AVENUE, FANWOOD, NEW JERSEY 07023

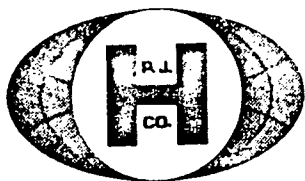
(201) 322-6500

TEST BORING DATA

| | | | |
|---|-------------|---------------------------|----|
| Project: American Cyanamid | | TEST HOLE NO. 5-E | |
| Location: Carteret, New Jersey | | Sheet | of |
| Boring Contractor: Philip J. Healey Company | | Surface Elevation: | |
| Inspector: | | Ground water observations | |
| Date Started: 7/31/81 | Depth: 7.0' | Date: 7/31/81 | |
| Date Completed: 7/31/81 | Depth: | Date: | |

| | Casing Blows | SAMPLE NO. DEPTH | | BLOWS ON SPOON | | | | REC. | SAMPLE IDENTIFICATION AND PROFILE CHANGE | ELEV. |
|----|--------------|------------------|------|----------------|---------|----------|----------|------|--|-------|
| | | | | 0 6 | 6 12 | 12 18 | 18 24 | | | |
| | | S-1 | 0.0 | 3.0 | P | P | P | P | SLUDGE | |
| | | | | | P | P | | | | |
| | | | | | | | | | | |
| 5 | | S-2 | 3.0 | 6.0 | P | P | P | P | | |
| | | | | | P | P | | | | |
| | | | | | | | | | | |
| | | S-3 | 6.0 | 9.0 | P | P | P | P | | 7.0' |
| | | | | | P | P | | | | |
| | | | | | | | | | | |
| 10 | | S-4 | 9.0 | 12.0 | P | P | P | P | | |
| | | | | | P | P | | | | |
| | | | | | | | | | PEAT | |
| | | S-5 | 12.0 | 15.0 | P | P | P | P | | |
| | | | | | P | P | | | | |
| 15 | | S-6 | 15.0 | 18.0 | P | P | P | P | | |
| | | | | | P | P | | | | |
| | | | | | | | | | | |
| | | S-7 | 18.0 | 21.0 | P | P | P | P | | |
| 20 | | | | | P | P | | | | |
| | | | | | | | | | | |
| | | S-8 | 21.0 | 24.0 | P | P | P | P | | 23.0' |
| | | | | | P | P | | | | |
| | | | | | | | | | Gray Organic SILT, vegetation | |
| 25 | | S-9 | 24.0 | 27.0 | P | P | P | P | | |
| | | | | | P | P | | | | |
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| 40 | | | | | | | | | | |

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|-----------------|-------|-----------------------|-----------------------|--------|----|-------------|----------|---------------------------|
| I. D. Casing | in | Wgt. Hammer on Casing | lb | Symbol | a. | s. | l. | t. |
| I. D. Spoon | 1-3/8 | in | Wgt. Hammer on Spoon | 140 | lb | Proportions | and | some little trace |
| Type Core Drill | | | Drop Hammer on Casing | | in | % By Wgt. | 35 to 50 | 20 to 35 10 to 20 1 to 10 |
| Core Dia. | in | | Drop Hammer on Spoon | 30 | in | | | |



PHILIP J. HEALEY COMPANY est. 1870

43 SOUTH AVENUE, FANWOOD, NEW JERSEY 07023

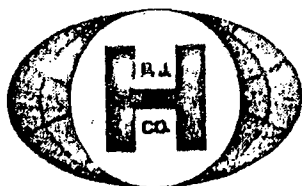
(201) 322-6500

TEST BORING DATA

Project: American Cyanamid TEST HOLE NO. 5-C
 Location: Carteret, New Jersey Sheet 1 of 1
 Boring Contractor: Philip J. Healey Company Surface Elevation:
 Inspector: Ground water observations
 Date Started: 7/30/81 Depth: 6.0' Date: 7/30/81
 Date Completed: 7/30/81 Depth: Date:

| | Casing Blows | SAMPLE NO. DEPTH | | BLOWS ON SPOON | | | | REC. | SAMPLE IDENTIFICATION AND PROFILE CHANGE | ELEV. |
|----|-----------------|---------------------|-----------|----------------|---------|----------|----------|------|--|-------|
| | | | | 0 6 | 6 12 | 12 18 | 18 24 | | | |
| | | S-1 | 0.0 3.0 | P | P | P | P | | SLUDGE | |
| | | | | P | P | | | | | |
| | | | | | | | | | | |
| 5 | | S-2 | 3.0 6.0 | P | P | P | P | | | |
| | | | | P | P | | | | | |
| | | | | | | | | | | |
| | | S-3 | 6.0 9.0 | P | P | P | P | | | 6.0' |
| | | | | P | P | | | | | |
| | | | | | | | | | | |
| 10 | | S-4 | 9.0 11.0 | P | P | P | P | | | |
| | | | | | | | | | PEAT | |
| | | S-5 | 11.0 15.0 | P | P | P | P | | | |
| | | | | P | P | P | P | | | |
| | | | | | | | | | | 14.0' |
| 15 | | | | | | | | | Brn. f Silty CLAY, vegetation | |
| | | S-6 | 15.0 18.0 | P | P | P | P | | | 17.5' |
| | | | | P | P | | | | End of Boring | 18.0' |
| | | | | | | | | | | |
| 20 | | | | | | | | | | |
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|-------------------|----|-----------------------|-----|--------|-------------|----------|----------|----------|---------|
| I. D. Casing | in | Wgt. Hammer on Casing | lb | Symbol | a. | s. | l. | t. | |
| I. D. Spoon 1-3/8 | in | Wgt. Hammer on Spoon | 140 | lb | Proportions | and | some | little | trace |
| Type Core Drill | | Drop Hammer on Casing | | in | % By Wgt. | 35 to 50 | 20 to 35 | 10 to 20 | 1 to 10 |
| Core Dia. | in | Drop Hammer on Spoon | 30 | in | | | | | |



PHILIP J. HEALEY COMPANY est. 1870

43 SOUTH AVENUE, FANWOOD, NEW JERSEY 07023

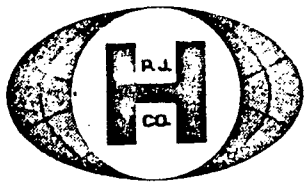
(201) 322-6500

TEST BORING DATA

Project: American Cyanamid TEST HOLE NO. 6-E
 Location: Carteret, New Jersey Sheet 1 of 1
 Boring Contractor: Philip J. Healey Company Surface Elevation:
 Inspector: Ground water observations
 Date Started: 7/29/81 Depth: Date: 7/29/81
 Date Completed: 7/30/81 Depth: Date: 7/30/81

| | Casing Blows | SAMPLE NO. DEPTH | | BLOWS ON SPOON | | | | REC. | SAMPLE IDENTIFICATION AND PROFILE CHANGE | ELEV. |
|----|-----------------|---------------------|-----------|----------------|---------|----------|----------|------|--|-------|
| | | | | 0 6 | 6 12 | 12 18 | 18 24 | | | |
| | | S-1 | 0.0 2.0 | P | P | P | P | | SLUDGE | |
| | | S-2 | 2.0 4.0 | P | P | P | P | | | |
| 5 | | S-3 | 4.0 6.0 | P | P | P | P | | | |
| | | S-4 | 6.0 8.0 | P | P | P | P | | | |
| | | S-5 | 8.0 10.0 | P | P | P | P | | | |
| 10 | | S-6 | 10.0 12.0 | 4 | 4 | 5 | 4 | | | |
| | | S-7 | 12.0 14.0 | 1 | 1 | 5 | 4 | | | |
| 15 | | S-8 | 14.0 16.0 | 3 | 3 | 3 | 4 | | | |
| | | S-9 | 16.0 18.0 | 4 | 2 | 2 | 3 | | | 18.0' |
| | | S-10 | 18.0 20.0 | 3 | 3 | 4 | 3 | | PEAT, Blk. Organic Silt | |
| 20 | | S-11 | 20.0 23.0 | 3 | 3 | 4 | 3 | | | |
| | | | | 4 | 4 | | | | | |
| | | S-12 | 23.0 26.0 | 4 | 3 | 4 | 4 | | Gray Red SAND, cf Silt, Clay | 25.0' |
| 25 | | | | 6 | 9 | | | | | 26.0' |
| | | | | | | | | | End of Boring | |
| | | | | | | | | | | |
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| 30 | | | | | | | | | | |
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| 35 | | | | | | | | | | |
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| 40 | | | | | | | | | | |

| | | | | | | | | |
|-----------------|----------|-----------------------|--------|-------------|----------|----------|----------|---------|
| I. D. Casing | in | Wgt. Hammer on Casing | lb | Symbol | a. | s. | l. | t. |
| I. D. Spoon | 1-3/8 in | Wgt. Hammer on Spoon | 140 lb | Proportions | and | some | little | trace |
| Type Core Drill | | Drop Hammer on Casing | in | % By Wgt. | 35 to 50 | 20 to 35 | 10 to 20 | 1 to 10 |
| Core Dia. | in | Drop Hammer on Spoon | 30 in | | | | | |



PHILIP J. HEALEY COMPANY est. 1870

43 SOUTH AVENUE, FANWOOD, NEW JERSEY 07023

(201) 322-6500

TEST BORING DATA

Project: American Cyanamid TEST HOLE NO. 6-C
 Location: Carteret, New Jersey Sheet 1 of 1
 Boring Contractor: Philip J. Healey Company Surface Elevation:
 Inspector: Ground water observations
 Date Started: 7/29/81 Depth: 4.0' Date: 7/29/81
 Date Completed: 7/30/81 Depth: Date: 7/30/81

| | Casing Blows | SAMPLE NO. DEPTH | | BLOWS ON SPOON | | | | REC. | SAMPLE IDENTIFICATION AND PROFILE CHANGE | ELEV. |
|----|-----------------|---------------------|------|----------------|---------|----------|----------|------|--|-------|
| | | | | 0 6 | 6 12 | 12 18 | 18 24 | | | |
| | | S-1 | 0.0 | 3.0 | P | P | P | P | SLUDGE | |
| | | | | | P | P | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| 5 | | S-2 | 3.0 | 6.0 | P | P | P | P | SLUDGE | 4.0' |
| | | | | | P | P | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | S-3 | 6.0 | 9.0 | P | P | P | P | SLUDGE | |
| | | | | | P | P | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| 10 | | S-4 | 9.0 | 12.0 | P | P | 4 | 4 | SLUDGE | |
| | | | | | 4 | 3 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | S-5 | 12.0 | 15.0 | 4 | 3 | 4 | 4 | SLUDGE | |
| | | | | | 3 | 2 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| 15 | | S-6 | 15.0 | 18.0 | 3 | 4 | 4 | 3 | PEAT | 15.0' |
| | | | | | 3 | 2 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | S-7 | 18.0 | 22.0 | 3 | 3 | 1 | 1 | PEAT | |
| | | | | | 1 | P | P | 1 | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | S-8 | 22.0 | 26.0 | 3 | 1 | 1 | 3 | PEAT | |
| | | | | | 1 | 2 | 1 | 2 | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | S-9 | 26.0 | 29.0 | 4 | 6 | 9 | 9 | Gray mf SAND, Silt, Clay | 27.0' |
| | | | | | 14 | 19 | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| 30 | | | | | | | | | End of Boring | 29.0' |
| | | | | | | | | | | |
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| | | | | | | | | | End of Boring | |
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| 35 | | | | | | | | | End of Boring | |
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| 40 | | | | | | | | | End of Boring | |
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|-----------------|----------|-----------------------|--------|-------------|----------|----------|----------|---------|
| I. D. Casing | in | Wgt. Hammer on Casing | lb | Symbol | a. | s. | l. | t. |
| I. D. Spoon | 1-3/8 in | Wgt. Hammer on Spoon | 140 lb | Proportions | and | some | little | trace |
| Type Core Drill | | Drop Hammer on Casing | in | % By Wgt. | 35 to 50 | 20 to 35 | 10 to 20 | 1 to 10 |
| Core Dia. | in | Drop Hammer on Spoon | 30 in | | | | | |